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GB 1480061 A

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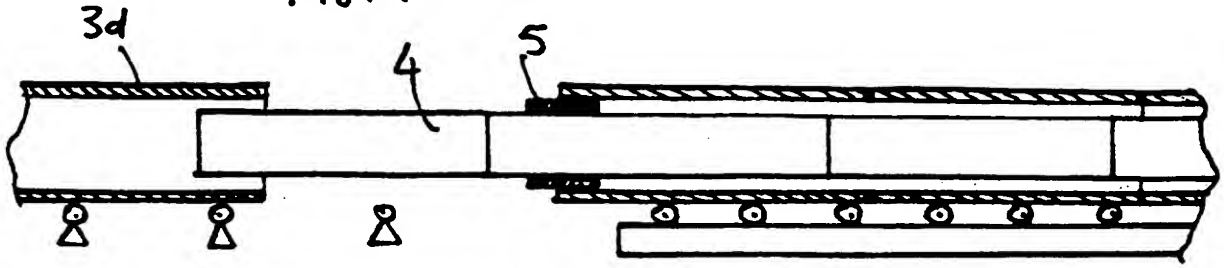
(54) Process for joining pipes

(57) The process, for constructing a pipeline comprising an outer pipe 3d formed of a weldable metal material and an inner pipe 4 formed of a polymeric material, comprises the steps of positioning a length of liner pipe 4 within a first length of outer pipe, the liner pipe 4 being radially undersized such that there is an annular space between the liner pipe 4 and outer pipe 3d, positioning a second length of outer pipe about the said liner pipe 4 such that said second length of outer pipe abuts against the first length of outer pipe, positioning a heat shield sleeve 5 about the liner pipe in said annular space and within the bore of the first and second lengths of outer pipe such that it overlaps the location at which the first and second lengths of outer pipe abut, welding the first and second lengths of outer pipe together at the said location, removing the heat shield sleeve 5 and thereafter optionally causing or allowing the liner pipe 4 to expand radially outwardly towards the inner wall of the outer pipe 3d.

FIG. 1c



GB 2 298 689 A

FIG. 1a

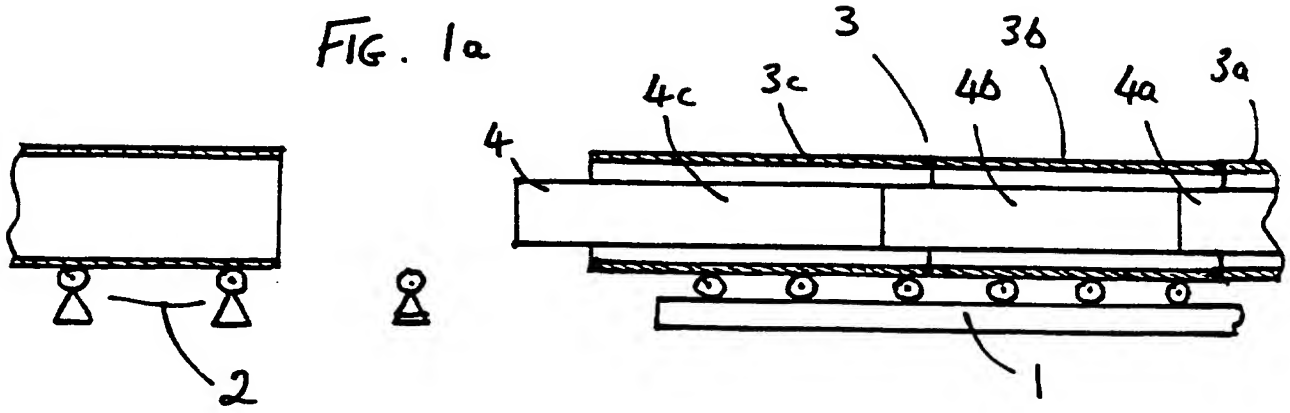


FIG. 1b

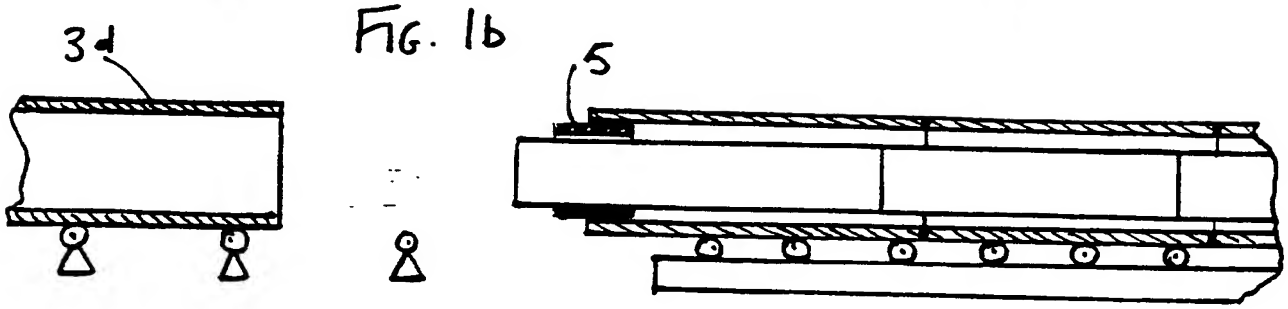


FIG. 1c

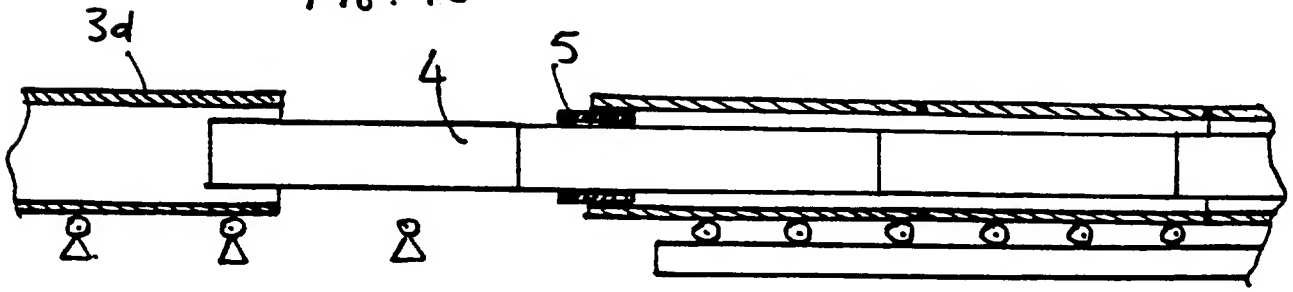
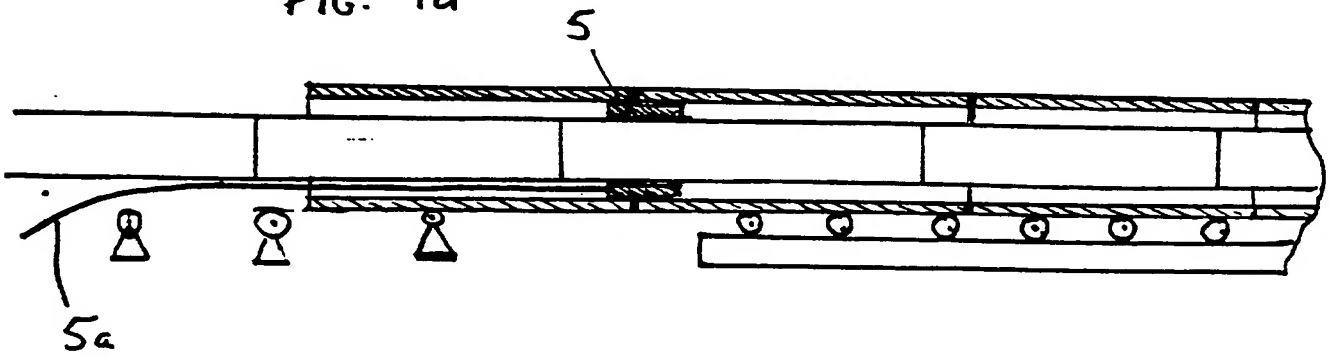


FIG. 1d



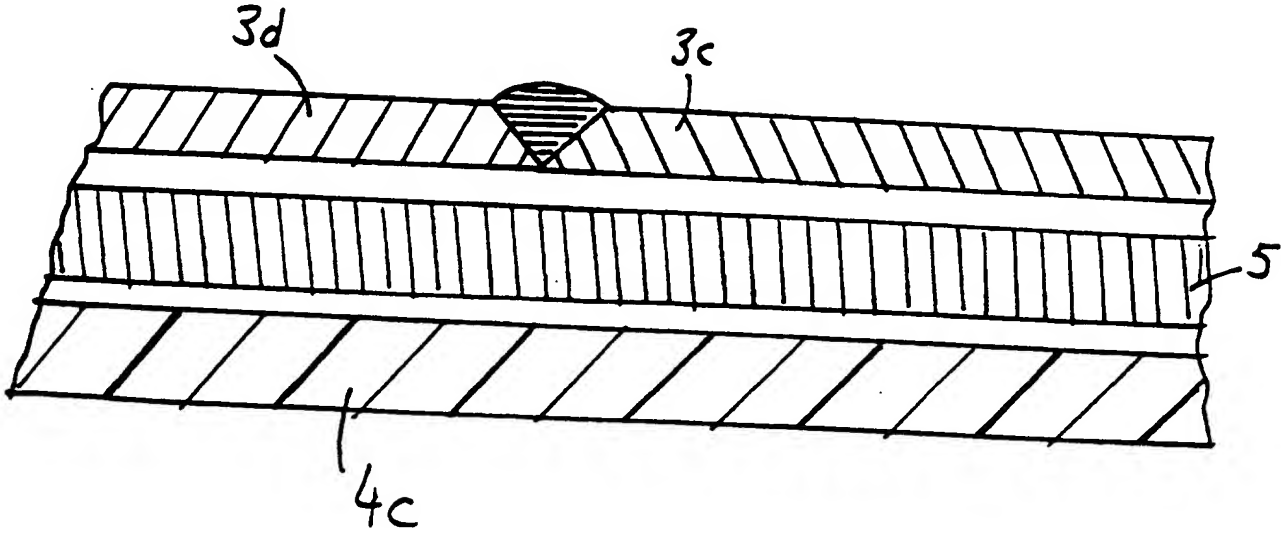


FIG. 2

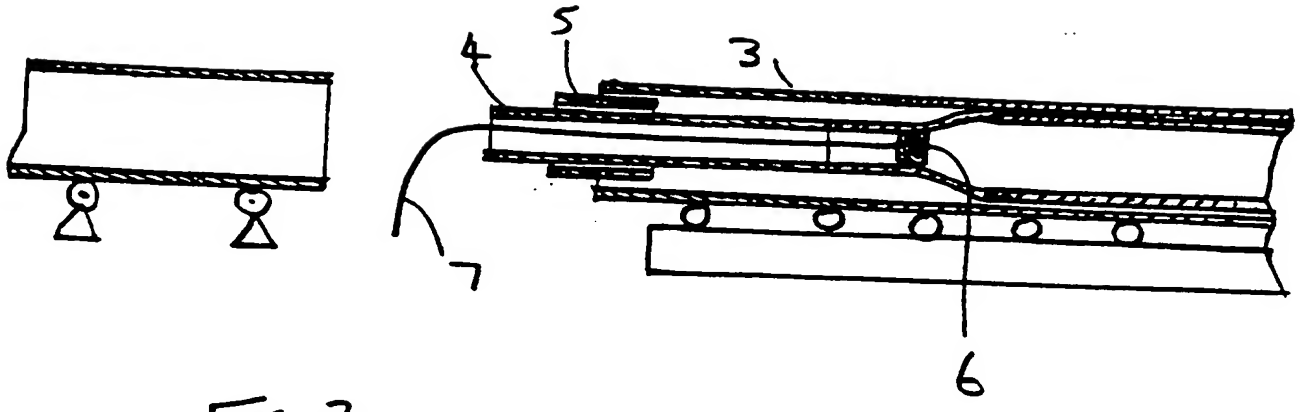


FIG. 3

PROCESS FOR JOINING PIPES

This invention relates to a process for joining pipes to form pipelines, and in particular pipelines intended for off-shore applications.

Off-shore pipelines, for example those intended to carry injection water or petroleum and gas products from off-shore drilling rigs or terminals can consist of a steel outer pipe and an inner liner pipe formed of a polymeric material such as polyethylene or polyvinylidene difluoride.

Pipelines of this sort may be constructed by coupling together adjacent lengths of steel pipe with mechanical coupling means, or the adjacent lengths of steel pipe can be welded together. A problem with welding together lengths of steel pipe is that during the welding process, the polymeric liner pipe can be damaged substantially by the heat of the welding operation. For this reason, it is possible to interpose protective heat-resistant sleeves between the polymeric liner pipe and the outer metal pipe in the region of the weld interface so as to shield the liner pipe from the extremes of temperature encountered or generated during welding. However, the use of such protective sleeves in itself creates a further problem in

that the presence of the sleeve between the liner pipe wall and the outer metal pipe wall results in an inwards bulge in the liner pipe wall, commonly known as a "bore upset". The presence of bore upsets at regular intervals along the pipe can interfere with smooth flow of fluid along the pipeline, creating turbulence in the region of the bore upsets, and can make maintenance and other operations using pipeline pigs rather more difficult. Furthermore, in some instances, the material being carried through the pipe will contain sands or other abrasive materials and the presence of the bore upsets can lead to increased liner erosion by the abrasive materials.

Alternative techniques that allow the liner pipe bore to remain constant involve the added cost and complexity of enlarged external connector sleeves within which heat resistant barriers can be installed. Such external upsets can create difficulties during pipeline handling and laying.

It is an object of the present invention to overcome the aforementioned problems, and the invention aims to accomplish this by introducing the liner pipe into the outer metal pipe when the liner pipe is in a radially undersized condition (e.g. has been radially compressed or contracted or is of a naturally smaller diameter), and using a heat shield sleeve which can be displaced axially following each welding operation.

Accordingly, the invention provides a process for constructing a pipeline comprising an outer pipe formed of

a weldable metal material and an inner pipe formed of a polymeric material; the process comprising the steps of positioning a length of liner pipe within a first length of outer pipe, the liner pipe being radially undersized such that there is an annular space between the liner pipe and outer pipe; positioning a second length of outer pipe about the said liner pipe such that said second length of outer pipe abuts against the first length of outer pipe; positioning a heat shield sleeve about the liner pipe in said annular space and within the bore of the first and second lengths of outer pipe such that it overlaps the location at which the first and second lengths of outer pipe abut; welding the first and second lengths of outer pipe together at the said location, removing the heat shield sleeve; and therefore optionally causing or allowing the liner pipe to expand radially outwardly towards the inner wall of the outer pipe.

In a particular aspect, the invention provides a process for constructing a pipeline comprising an outer pipe formed of a weldable metal material and an inner liner pipe formed of a polymeric material; the process comprising in sequence the steps of:

a) positioning a first length of radially undersized liner pipe within a first length of outer pipe such that the axial end of the liner pipe protrudes from the end of the length of outer pipe;

b) placing a heat shield sleeve about the first length of liner pipe such that part of the axial length of the

heat shield sleeve is within the bore of the first length of outer pipe and part of the axial length of the heat shield sleeve protrudes beyond the end of the first length of outer pipe;

c) joining a second length of liner pipe to the said first length of liner pipe;

d) positioning a second length of outer pipe about the said second length of the liner pipe and the protruding end of the first length of liner pipe, such that it abuts the first length of outer pipe, and such that the axial end of the second length of liner pipe protrudes from the end of the second length of outer pipe;

e) welding the first and second lengths of outer pipe together; the heat shield sleeve serving to prevent or reduce substantially the heat transmitted to the inner liner pipe;

f) sliding back the heat shield sleeve along the liner pipe towards or past the free end of the second length of outer pipe; and

g) optionally causing or allowing the liner pipe to expand radially outwardly towards the inner wall of the outer pipe.

The first and second lengths of liner pipe are preferably joined together by means of welding, and most preferably are joined together by butt welding. Butt welding methods are known *per se* and need not be described in any detail here.

The inner liner pipe is conveniently formed from a polyolefin such as polyethylene or polypropylene, or may be formed from a material such as polyvinylidene difluoride. The polymeric liner pipe may be of a single layer or multi-layer construction. Where it is of multi-layer construction, it may for example have one or more barrier layers for reducing the permeability of the liner pipe to materials transported along the pipe. For example, where it is desired to reduce the permeability of the pipe wall to hydrocarbon materials, a polyamide barrier layer may be employed.

The heat shield sleeve will be of sufficient axial length to shield those regions of the liner pipe that would otherwise be subjected to intense heat as a result of the welding together of the outer metal pipe. The heat shield sleeve may be formed from a suitable thermal insulating material, for example a suitable ceramic material.

In order to allow the heat shield sleeve to be removed after the lengths of metal outer pipe have been welded together, there must be sufficient clearance between the outer wall of the liner pipe and the inner wall of the outer metal pipe. It may however be undesirable that there should exist a natural significant clearance between the inner and outer pipe walls since this could reduce the effectiveness in operation of the lining in terms of barrier performance and mechanical stability. The liner pipe may therefore be prepared in a radially compressed or contracted condition which is then expanded to its original

condition or thereabouts at a convenient time after installation. The liner pipe may be radially compressed to a reduced diameter state by means of the "ROLL DOWN" technique disclosed in, for example, UK Patent GB 2084686B. The "ROLL DOWN"™ method involves progressively reducing the outer diameter of a pipe by passing through successive sets of compression rollers. Following installation of the pipeline, or predetermined lengths of pipeline, the liner may be expanded to its original diameter or thereabouts such that it contacts fully the metal pipe bore, by means of heat, gas pressure, or combinations of the two. Alternatively, in certain instances the compressed contracted pipe may be left to revert under pipeline operational pressure to its original diameter or thereabouts such that it contacts fully the metal pipe bore.

As a further alternative, a naturally undersized liner pipe may be installed and then expanded, for example in accordance with known techniques for radially stretching pipes.

The process of the present invention is especially useful for pipe-laying operations conducted from pipe-laying ships or pipe-laying barges which have the capacity for carrying only relatively short lengths of metal pipe. In such instances, a large number of lengths of pipe (or "joints") may be required to construct a given pipeline.

The process of the present invention will now be illustrated by reference to the particular embodiments

shown schematically in the accompanying drawings of which:

Figures 1a to 1d illustrate schematically the various steps in a process according to one embodiment of the invention;

Figure 2 is an enlarged sectional elevation of part of the pipe joint shown in Figure 1d; and

Figure 3 discloses in schematic form, apparatus for carrying out a modification of the process illustrated in Figures 1a to 1d.

As can be seen from Figures 1a to 1d, an apparatus for carrying out the process of the present invention comprises a pipeline supporting arrangement 1 and a pipe support arrangement 2. A number of lengths of steel pipe are shown as being supported on the pipeline supporting arrangement 1. Thus a first length of pipeline comprises lengths 3a, 3b, 3c of steel pipe welded together in conventional fashion. Disposed within the outer steel pipe 3 is a liner pipe 4 consisting of lengths 4a, 4b, 4c butt welded together in standard fashion. The lengths of liner piper 4a, 4b, 4c as shown are of reduced diameter compared to the inner diameter of the bore of the metal outer pipe as a consequence of having been radially compressed or contracted by means of the "ROLL DOWN"™ method disclosed in, for example, UK Patent No. GB 2084686B. As can be seen, the end of liner pipe length 4c protrudes from the end of length 3c of outer metal pipe.

In the process of the invention, a sleeve 5 formed of a heat resistant ceramic material is positioned about the

liner pipe length 4c as shown in Figure 1b such that part of the sleeve 5 is within the bore of the outer pipe 3 whilst the remaining part of the sleeve protrudes from the end of the outer pipe 3. The liner pipe is held in position by suitable clamping means, for example, one of the clamps of a conventional polyethylene pipe butt welding machine.

As shown in Figure 1c, a further length of liner pipe 4d is then welded to length 4c using a butt welding machine which may be of known type. Since butt welding is a well established technique, details of the butt welding apparatus and butt welding process conditions need not be described here.

Once the liner pipe 4d has been butt welded to liner pipe 4c, a length 3d of outer metal pipe is introduced over the liner pipe 4d and rolled along the pipe supporting arrangement 2 and into contact with the end of outer metal pipe length 3c as shown in Figure 1d. As is apparent from the enlarged view Figure 2, the ends of pipe lengths 3c and 3d are inclined such that when they abut, an annular groove of V-shaped cross-section is formed within which the weld metal can be deposited. The pipe lengths 3c and 3d are then welded together by, for example, by gas or electric arc welding in conventional manner. Thanks to the presence of the heat insulating ceramic sleeve 5, the extreme temperatures required to bring about a welded joint at the interface between steel pipe lengths 3c and 3d are not transmitted through to the underlying polymeric material of

the liner pipe. Consequently, damage to the liner pipe is avoided.

Once the metal pipe elements 3c and 3d have been welded together, and following a reasonable period of cooling, the ceramic sleeve can easily be removed, for example by towing it along the annulus between pipe 3d and liner 4d to protrude from the free end of pipe 3d using a length of cable 5a attached to the sleeve for the purpose.

At this point, it may be appropriate to expand the liner pipe to its original size or thereabouts and this can be achieved by a variety of methods known *per se*, for example by heating, or by using gas pressure, or a combination of the two. Expansion of the liner pipe may be carried out at regular intervals, or the expansion process may be carried out upon completion of the pipeline.

Figure 3 illustrates a modified set-up in which an expanding plug 6 is present in the pipe liner at a position two sections removed from the end, the plug 6 being connected to a gas line 7. Following welding of the steel pipe elements 3d and 3c, gas is passed through the gas line to expand the liner pipe and the plug 6 is simultaneously expanded by remote mechanical means until full contact between the liner pipe and steel pipe is established. The gas line and expanding plug 6 are then withdrawn prior to the next sections of liner pipe and outer metal pipe being connected and are then reinserted to expand a further length of the reduced diameter liner pipe.

The advantage of the process of the present invention

is that it gives rise to a pipeline wherein there are substantially no bore upsets which can create turbulent flow and which can make operations with pipeline pigs difficult.

It will readily be apparent that numerous alterations and modifications may be made to the embodiments illustrated in the accompanying drawings without departing from the principles underlying the invention.

For example, rather than using a liner pipe which has been radially compressed, a naturally radially undersized liner pipe may be installed and then expanded or radially stretched to the desired diameter. Techniques are known, for example, wherein the diameter of a pipe can be stretched by up to about 8%.

All such modifications and alterations are intended to be embraced by the present Application.

CLAIMS

1. A process for constructing a pipeline comprising an outer pipe formed of a weldable metal material and an inner pipe formed of a polymeric material; the process comprising the steps of positioning a length of liner pipe within a first length of outer pipe, the liner pipe being radially undersized such that there is an annular space between the liner pipe and outer pipe; positioning a second length of outer pipe about the said liner pipe such that said second length of outer pipe abuts against the first length of outer pipe; positioning a heat shield sleeve about the liner pipe in said annular space and within the bore of the first and second lengths of outer pipe such that it overlaps the location at which the first and second lengths of outer pipe abut; welding the first and second lengths of outer pipe together at the said location, removing the heat shield sleeve; and therefore optionally causing or allowing the liner pipe to expand radially outwardly towards the inner wall of the outer pipe.

2. A process for constructing a pipeline comprising an outer pipe formed of a weldable metal material and an inner liner pipe formed of a polymeric material; the process comprising in sequence the steps of:

a) positioning a first length of radially undersized liner pipe within a first length of outer pipe such

that the axial end of the liner pipe protrudes from the end of the length of outer pipe;

b) placing a heat shield sleeve about the first length of liner pipe such that part of the axial length of the heat shield sleeve is within the bore of the first length of outer pipe and part of the axial length of the heat shield sleeve protrudes beyond the end of the first length of outer pipe;

c) joining a second length of liner pipe to the said first length of liner pipe;

d) positioning a second length of outer pipe about the said second length of the liner pipe and the protruding end of the first length of liner pipe, such that it abuts the first length of outer pipe, and such that the axial end of the second length of liner pipe protrudes from the end of the second length of outer pipe;

e) welding the first and second lengths of outer pipe together; the heat shield sleeve serving to prevent or reduce substantially the heat transmitted to the inner liner pipe;

f) sliding back the heat shield sleeve along the liner pipe towards or past the free end of the second length of outer pipe; and

g) optionally causing or allowing the liner pipe to expand radially outwardly towards the inner wall of the outer pipe.

3. A process according to Claim 2 wherein the first and second lengths of liner pipe are joined together by means of welding.

4. A process according to Claim 3 wherein the first and second lengths of liner pipe are joined together by means of butt welding.

5. A process according to any one of the preceding Claims wherein the liner pipe is formed from a polyolefin.

6. A process according to Claim 5 wherein the polyolefin is polyethylene or polypropylene.

7. A process according to any one of Claims 1 to 4 wherein the liner pipe is formed from polyvinylidene difluoride.

8. A process according to any one of the preceding Claims wherein the liner pipe has a single layer construction.

9. A process according to any one of Claims 1 to 7 wherein the liner pipe has a multi-layer construction.

10. A process according to Claim 9 wherein the liner pipe has one or more barrier layers for reducing the permeability of the liner pipe to materials

transported along the pipe.

11. A process according to any one of the preceding Claims wherein the heat shield sleeve is formed from a thermal insulating material.

12. A process according to Claim 11 wherein the thermal insulating material is a ceramic material.

13. A process according to any one of the preceding Claims wherein the liner pipe is prepared in a radially compressed or contracted condition which is then expanded to its original condition or thereabouts after installation.

14. A process according to Claim 13 wherein the liner pipe has been radially compressed to a reduced diameter state by a method involving progressively reducing the outer diameter of the pipe by passing it through successive sets of compression rollers.

15. A process according to Claim 13 or Claim 14 wherein, following installation of the pipeline, or predetermined lengths of pipeline, the liner pipe is expanded to its original diameter or thereabouts such that it contacts fully the metal pipe bore, by means of heat, gas pressure, or combinations of the two.

16. A process according to Claim 13 or Claim 14 wherein the compressed contracted pipe is left to revert under pipeline operational pressure to its original diameter or thereabouts such that it contacts fully the metal pipe bore.

17. A process according to any one of Claims 1 to 12 wherein a naturally undersized liner pipe is installed and then expanded.

18. A process substantially as described herein with reference to the accompanying drawings.

The Patent Office

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Application No: GB 9503495.5
Claims searched: 1-18

Examiner: Roger Binding
Date of search: 2 May 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F2G (G18); F2P (PTBL, PTBM)

Int Cl (Ed.6): F16L 13/02, 13/04, 13/06, 58/02, 58/18

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB 1480061 A (ENGLISH CLAYS), see Figs 5-12 and page 4, line 14 onwards.	1, 2

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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